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BACILLUS MYCOGENES (BACTERIUM MUCOGENUM), NOV. SPEC. AN ORGANISM BELONGING TO THE BACILLUS MUCOSUS CAPSULATUS GROUP.*

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THE place of members of the group of the bacillus mucosus capsulatus in human pathology, and their etiological importance in the production of inflammatory conditions, has been emphasized so much in the past few years, that it is needless to review in any detail, the literature of the subject.

The recent articles of Friche, Howard, Clairmont, Strong, Blumer, Mallory and Wright, and a number of others, have served to elucidate some of the problems presented by the description of a large number of capsulated bacteria closely related to the organisms originally described by Escherich, Friedländer and Pfeiffer. The most recent and most comprehensive work upon these organisms is that of Perkins[1] who had exceptional opportunities for studying these bacteria, in consequence of their frequent appearance in the autopsies in Cleveland. From Perkins' investigation, it is apparent that, among the large number of capsulated organisms described as distinct species, but three main types can be established.

All the organisms, thus far described, are fairly large non-flagellated bacteria, surrounded by a mucilaginous capsule; they grow upon the surface of media, as abundant, slimy, elevated, discrete or confluent colonies and fail to secrete any proteolytic enzyme. The different organisms differ much, however, in their action upon carbohydrates.

The majority of the species are capable of fermenting all the known carbohydrates, (including sugars, some of the starches and some of the alcohols), with the production of acid and the evolution of gas made up of a mixture of hydrogen and carbon dioxid.

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[1] *Jour. Infect. Dis.*, 1904, 1, p. 241.

These species all acidify and coagulate milk, and are identical with the bacillus lactis aërogenes described by Escherich.

Certain species fail to ferment lactose, and because of inability to split up this sugar, fail also to coagulate milk. Such organisms are identical with the bacterium pneumonicum of Friedländer, usually known as Friedländer's bacillus. The fact that Friedländer's bacillus never coagulates milk has been overlooked by a number of observers, although this characteristic was pointed out as early as 1886 by Fluegge.[1]

Other organisms retain the capacity to coagulate milk and ferment lactose, but exert no fermentative action upon saccharose. They thus bear to the organisms fermenting all the carbohydrates, the same relation which the non-saccharose fermenting variety of the bacillus coli bears to the variety that acts on this sugar. The bacteria of this type are all identical with the bacillus acidi lactici of Hueppe, with which also is probably identical the bacterium duodenale described by Ford,[2] in the upper portion of the intestinal tract.

A number of other species have been described from time to time, with somewhat different cultural characters. The most important of these is the rhinoscleroma bacillus, whose identity is not firmly established either as a distinct species or as the etiological factor in rhinoscleroma. Apparently two capsulated organisms have been described in this connection. They have in common, growth in milk without coagulating it, but differ in their action on the sugars. Some species ferment dextrose and saccharose and are thus identical with the Friedländer bacillus, while others have no action upon the carbohydrates. Whether the latter microorganisms represent distinct types belonging to this group or whether they are degenerate forms of organisms originally possessing the capacity to break down the carbohydrates, has not yet been settled definitely. Perkins inclines to the opinion that the non-fermenting types are derived from organisms originally capable of attacking the sugars, and which in the course of adaptation to saprophytic existence have lost this character. However this may be, in no case have organisms of this type been found in definite association with pathological changes in man.

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[1] *Die Mikroorganismen*, 1886.

[2] *Studies from the Royal Victoria Hospital Reports*, 1903, 1.

A recent series of local infections in the wards of the Johns Hopkins Hospital, the exudate of which was subjected to bacteriological examination, and from all of which the same microorganism was obtained, possessing constant cultural features and marked pathogenic action upon the smaller animals, makes it apparent that certain non-fermenting microorganisms must be included in the group of the bacillus mucosus capsulatus and that these microorganisms in no sense may be looked upon as degenerate forms.

Case 1.—M. B., a girl, about 22 years old, was admitted to the surgical wards with pain in the right knee. For three years she had had some weakness in that knee, which cracked when under a strain, but 19 months previous she had fallen and bruised her knee, considerable ecchymosis resulting. There was nothing in her history to suggest gonorrhea and the chronicity of the case was the only thing to suggest tuberculosis. Upon examination there was found a flexion of the knee to about 15° with a further possible flexion of about 45°, an increase of fluid in the joint and some atrophy of the muscles above and below the joint.

The joint was opened and found to contain considerable clear fluid with a few flakes of fibrin and a slightly reddened synovial membrane, from which projected a few villi. The villi were removed, the joint washed out with salt solution, olive oil injected, and the joint closed. The wound healed rapidly, but there remained, however, some limitation of motion.

The excised villi were hardened and stained for bacteria and the fluid examined culturally. In the excised villi were found short oval bacteria, which retained Gram's stain and which were surrounded by a capsule. From the exudate grew but one species, and this was recognized as a probable member of the bacillus mucosus capsulatus group. Its major characters were identical with those of the other members of the group, but some striking differences were noted.

Morphologically, the organism is a short, plump bacterium, non-flagellated, non-spore-bearing, usually measuring less than 1 μ in its smaller diameter. Capsules can readily be demonstrated by Welch's method of precipitating the mucin of the capsule by glacial acetic acid and then applying gentian violet. They can be obtained most easily from the exudate of an inoculated animal, but may be seen in milk cultures and rarely upon the surface of agar-agar. The organism occurs singly or in pairs, depending upon the age of the culture, and may develop in short, or even in long chains of 10 to 15 elements. It retains Gram's stain in the tissues, but, as a general rule, may be decolorized in smears from cultures, especially if the alcohol be left on the film for some time.

Upon the surface of agar-agar, it grows as a porcelain-white, spreading mass of great viscosity. In broth and in milk this character is accentuated, the platinum loop drawing up strings of mucus-like material several inches long. Its colonies on agar-agar and on gelatin are smooth and elevated and when lightly seeded have the dew-drop or mucoid appearance characteristic of the capsulated bacteria. The organism fails to liquefy gelatin and blood-serum, and in stab culture exhibits the "nail-head" growth. It acidifies and coagulates milk in from one to five days, at the same time reducing the litmus, but no digestion of the casein occurs. Upon potato, it grows as a dark-brown slimy mass, but no gas blebs are formed either upon the surface of the potato or in the surrounding fluid. It does not form indol.

In these reactions the organism is identical with the main types of the group. Upon the employment of carbohydrates, however, either as a constituent of nutrient agar, or in combination with sugar-free broth in fermentation tubes, no gas formation was noted with any carbohydrate. The fluid in the closed arm of the fermentation tube always remained clear, the growth being limited to the bulb, where the reaction was always alkaline. As we have seen there is acid formed in milk; and on smears of the sugar agars, there is acid formation with lactose early, with glucose after several days; and some of the other sugars show acid reaction after standing a long time, but stabs do not show acid formation except at the surface and that after some time. Thus we see that while under certain conditions there is action upon lactose, if oxygen is present, there is in the ordinary sense of the word, no fermentation. Dextrose, saccharose, lactose, mannite and glycerin were tested and none of them were fermented by this organism.

Pathogenic action.—When freshly isolated, this organism was highly virulent for rabbits and guinea pigs: 1/100 c.c. of a 24-hour broth culture, injected subcutaneously killed a rabbit in 18 hours. The animal presented a typical picture of a bacteriemia, the organism being recovered from the heart's blood and from the internal organs. The recovered organism was similar to the organism injected, but all its cultures were more viscous. The virulence of this culture for rabbits was subsequently much lessened, as a month later, a rabbit survived a dose of two c.c. Guinea pigs were also very susceptible, and for them the virulence was great at the end of two months. They presented in all cases the picture of bacteriemia and one case which lived longer than the average, 15 hours, had a well developed peritonitis, but cultures showed only the presence of the organism injected. The organism recovered from all the animals was tested carefully with carbohydrates and in all cases the reactions were like those of the original culture.

Case 2.—W. H., colored, male, age about 30 years, was injured in a railway accident, "two cars ran over both legs". He was admitted to the hospital a few hours after the accident and the right foot was amputated and a plaster cast applied to the left foot, which was crushed without any lesion of the skin. The amputated stump healed readily, but the left foot became gangrenous, the gangrene gradually extending up the leg. There was no subcutaneous emphysema. The left leg was then amputated just above the edge of the gangrene. Upon incising the gangrenous part gas with a peculiar scorched odor and which burned when lighted, escaped. Both aërobic and anaërobic cultures were made from the gangrenous mass. The patient made a slow, but satisfactory recovery from the second operation.

Upon the anaërobic cultures an organism was obtained which was probably identical with the gas bacillus of Welch. From the aërobic cultures an organism was obtained which proved identical with the organism obtained from the previous case. It was also pathogenic to smaller animals, mice, guinea pigs and rabbits dying from inoculation with small amounts, within 15 hours.

Case 3.—P. T., colored, female, aged 20, was shot in the mouth, six weeks before admission to the hospital. The wound made by the bullet failed to heal, and there had been a constant discharge of pus and blood since the accident.

At operation a large abscess was found just behind the angle of the jaw on the right side and quite near the great vessels. The abscess was evacuated and some necrotic bone removed, but the bullet was not found. The wound did not heal well, and following the closure of the sinus, another abscess formed in about the same place. The wound was again opened and the pus evacuated, the bullet being found, and the wound allowed to heal by granulation. Recovery followed.

Cultures made from the pus at the second operation revealed a single microorganism, which was carefully studied and found to be identical with the one described in Case 1. It was pathogenic for mice and guinea pigs. It was not virulent for rabbits when tested some months after it was first isolated at a time when it might have lost its virulence for rabbits, as the other cultures did, in that length of time.

This organism has been kept in stock in the bacteriological laboratory of the Johns Hopkins Hospital since its original isolation and when tested recently, nearly a year after its original isolation, was found to give the same cultural reactions.

We thus have a species of microorganism obtained upon three different occasions, which is capable of causing mild inflammations especially of serous membranes in man, and is possessed of considerable virulence for smaller animals. It is furthermore characterized by certain fundamental peculiarities which place it in the group of the bacillus mucosus capsulatus, but differs from the other members of this group in its failure to ferment the carbohydrates.

So far as can be learned by examination of the literature, no organisms of this description have thus far been observed in human lesions, and I therefore feel justified in describing it as a new species for which I propose a name: Bacillus mycogenes (Bacterium mucogenum), nov. spec., Edwards, 1905.

In conclusion, it gives me great pleasure to express my thanks to Dr. Halsted for permission to report the cases from his surgical clinic, to Dr. Bloodgood and Dr. Haskell for the opportunities for research in the laboratory of surgical pathology, and to Dr. Ford for his suggestions in regard to the conduct of the bacteriological investigation.